

Strategic Plan for a National Climate Service

NOAA's Climate Service Development Team

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Preface

A team of scientists and managers (the Climate Services Development Team) from across the National Oceanic and Atmospheric Administration (NOAA) produced this draft document and offer it as a strategy to establish a National Climate Service. Its charge was to produce a document that begins to describe NOAA's vision for a National Climate Service that will meet the ever-increasing information needs of the nation as changes in the climate system move us beyond historical precedent.

Given the breadth of this challenge and the imperative to think in terms of how to build a new, closer relationship between societal outcomes and a stream of information services, the NOAA team began to view the National Climate Service as the core of a new federal initiative, involving relevant federal agencies, and drawing on their relationships with state, local, and private entities. There are a number of federal agencies with missions critical to producing Earth system information, others whose missions will be influenced substantially by the effects of climate change, and those who are essential to strategies to reduce dependence on fossil fuels. All need to be involved in ensuring the nation has the information it needs to respond and manage.

The process of assembling the vision for a National Climate Service inspired a close look at the breadth and experience of NOAA. Not only is NOAA home to the nation's National Weather Service (NWS), National Ocean Service (NOS), National Marine Fisheries Service (NMFS), and National Environmental Satellite and Data Information

1 Service (NESDIS), but the agency also sponsors, through the Office of Oceanic and
2 Atmospheric Research, a significant portion of the federal government's investment in
3 the science of climate and global change directed at achieving societal benefits. The
4 culture of this agency is shaped by the responsibility of serving the needs of others.
5 NOAA ensures that those needs are met with the highest quality of scientific
6 investigation in the climate system, information delivery, extension, and outreach
7 possible. NOAA is a natural choice to host a National Climate Service within a broader
8 national climate services partnership on climate adaptation and mitigation.

9
10 NOAA's interest in and readiness for this task are evidenced across the agency. NOAA's
11 programs range from efforts to ensure that new knowledge about climate change is built
12 into state-of-the-art weather and short-term climate forecasts, to working groups
13 considering what climate change means to shoreline development, fisheries, and drought
14 early warning and risk management. NOAA scientists have long played leadership roles
15 in the Intergovernmental Panel on Climate Change (IPCC) and national assessment
16 efforts. They are also recognized for research investments designed to support
17 knowledge for application and use.

18
19 The NOAA Climate Services Development Team prepared the following document as an
20 initial discussion piece around developing climate services to serve the present and future
21 needs of the nation. It is our intention that this document will motivate an active dialog so
22 that the ultimate strategy put forth is one that inspires participation, innovation, and
23 informed response.

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Introduction

Climate variability and change profoundly influence economic prosperity, human health, and national security, and present a substantial challenge to the nation and the world. Evidence of a changing climate – droughts, heavier downpours, warmer global surface temperatures, accelerating sea level rise, decreasing Arctic sea ice, retreating glaciers, changing ocean chemistry, and shifts in ecosystems - all demonstrate the critical need to increase support to the nation's capabilities to plan and adapt.

Societal demands for climate information to support decision-making have increased dramatically over the past decade and continue to grow. Federal resource managers, state, local and tribal governments, public and private businesses all recognize that a changing climate greatly complicates their ability to plan for tomorrow. In some instances, the near future under conditions of climate change will alter fundamentally the state of

Box 1. Key findings from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report on specific North American impacts that have been experienced or that have a very high confidence (at least 90% chance correct) of being experienced in the future:

North America has experienced locally severe economic damage, plus substantial ecosystem, social and cultural disruption from recent weather-related extremes, including hurricanes, other severe storms, floods, droughts, heat waves and wildfires.

The vulnerability of North America depends on the effectiveness and timing of adaptation and the distribution of coping capacity, which vary spatially and among sectors.

Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution.

Climate change will constrain North America's over-allocated water resources, increasing competition among agricultural, municipal, industrial and ecological uses.

Climate change impacts on infrastructure and human health and safety in urban centers will be compounded by aging infrastructure, maladapted urban form and building stock, urban heat islands, air pollution, population growth and an aging population.

Without increased investments in countermeasures, hot temperatures and extreme weather are likely to cause increased adverse health impacts from heat-related mortality, pollution, storm-related fatalities and injuries, and infectious diseases.

Disturbances such as wildfire and insect outbreaks are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons.

1 ecosystem services or the viability of critical infrastructure, such as levees or mass transit
2 systems. The examples in Box 1 emphasize the complexity of the challenge and the
3 widespread potential impacts of a changing climate.

4
5 Government, private, and academic resources exist to address particular elements of the
6 climate challenge. However, a comprehensive and coordinated approach does not exist at
7 the level necessary to support adaptation, management, and mitigation of a changing
8 climate and its impacts. The federal government has a responsibility to respond, and
9 numerous agencies have taken action. Over the past several years, the National Oceanic
10 and Atmospheric Administration (NOAA) has been actively developing a variety of
11 climate services. Other federal agencies have organized working groups to examine how
12 a changing climate may influence the public resources they manage and impact their
13 information needs and required capabilities. Considering the breadth of both existing and
14 emerging demands, it becomes clear that an effective response is well beyond the scope,
15 authority, or mission of any single federal agency. Ensuring societal benefits will require
16 the full commitment and coordination of agencies and organizations responsible for
17 improving scientific understanding (including projecting and predicting climate). This
18 should especially encompass those with missions that will be influenced by climate
19 variability and change, and constituencies whose actions will influence our overall
20 capacity to adapt. At this stage this document focuses on the emergence of a U.S.
21 capability to respond to the challenges and opportunities associated with a changing
22 climate. At the same time NOAA recognizes that our ability to provide Earth system

1 information is dependent upon global scientific engagement, and that confronting the
2 challenges associated with change is necessarily a global task.

3
4 Drawing on the efforts above noted, a NOAA team of experts across the agency has been
5 working over the past several months to develop a strategy to provide the necessary
6 climate services to the nation. These services must be able to meet the new and emerging
7 demands, support the development of adaptation and mitigation strategies, understand
8 different economic segments' needs, and help people to use climate data. Results of these
9 discussions have suggested the need for a two-pronged approach:

- 10
- 11 • A proposed *national climate services partnership* (the partnership) that draws upon
12 the full capacity of the nation would become the mechanism through which the
13 nation's goals with regard to managing risks associated with climate variability and
14 change are identified. The partnership would coordinate investments and activities
15 relevant to the production, distribution, and application of climate information. The
16 focus of the partnership is on ensuring that highly usable, actionable, issue-focused
17 information is produced, evaluated, and distributed. The intention is that the various
18 institutions throughout the nation, including universities, federal, state and local
19 science and management agencies, tribal governments, non-governmental
20 organizations (NGOs), and the private sector, would work in close collaboration
21 through the national climate services partnership.

- 1 • The proposed establishment, within NOAA, of a *National Climate Service* that would
2 be the nation's identified, accessible, authoritative, and centralized point of entry for
3 routine and timely climate information. This role for NOAA was mandated by the
4 National Climate Program Act of 1978 and is included in emerging legislation for a
5 National Climate Service (U.S. Senate Bill S. 2307, 110th Congress, 2007). This
6 service would encompass, for example, historical and real-time data, monitoring and
7 assessments, research and modeling, predictions and projections, decision support
8 tools, and the development and delivery of valued climate services.

9
10 This document is presented in two parts. The first provides a roadmap of a proposed
11 national dialogue among agencies and organizations to develop a national climate
12 services partnership, convened by NOAA. The second part of the document describes
13 NOAA's strategic plan to establish a National Climate Service providing a high-level
14 conceptualization of the National Climate Service's role and responsibilities. Discussion
15 of implementation issues, including possible organizational changes, is still underway.

16 This document should not be interpreted as advocating for any specific organizational
17 structure or change. It is NOAA's hope that discussions of this draft Strategy document
18 with our core partners and users (e.g. resource managers, federal, state, and local
19 governments, federal mission agencies, private sector, non-governmental organizations,
20 academia) will help refine the plans for a national climate service partnership and a
21 National Climate Service, and inform future discussions of agency organization and
22 program management.

Part 1. A Proposal to Convene a National Climate Services Partnership

Scientific bodies (e.g., National Academy of Sciences), Congress, mission agencies, state and federal resource managers, and others have begun to define the concept of climate services¹. They have also begun to suggest ways in which research enterprises and operational practices can be organized to be responsive to user needs, such as NOAA's own stewardship responsibilities. This document draws considerably on this experience. The following sections offer a proposal for a vision, mission, and principles to develop and sustain a national climate services partnership. This document is intended to offer a starting point for further discussion and refinement with partners.

The time is right to address these issues. Congress, federal, state, local, and tribal governments, and the private sector are all looking for guidance to plan for and adapt to a changing climate. In a recent review of the U.S. government investment in climate science and application, the National Research Council (2007)² found that substantial progress has been made in improving fundamental understanding of the climate system. They also noted there has been less success applying this understanding to manage the risks and opportunities of a changing climate. The NRC indicates that, in some cases, climate science has matured to a point where useful products and services have been developed and are routinely delivered to support decision-making. However, the

20

¹ National Research Council (2001) *A Climate Services Vision* (Natl Acad Press, Washington, DC)
Miles EL, Snover AK, Binder LCW, Sarachik ES, Mote PW, Mantua N (2006) *Proceedings National Academy Sciences* 103:19616-19623.

² National Research Council (2007) *Evaluating Progress of the U.S. Climate Change Science Program* (Natl Acad Press, Washington, DC)

1 partnership proposed here will have to identify new and emerging needs to guide future
2 observation, research, modeling, and forecast development activities.

3
4 Climate influences many aspects of our lives, including human health and welfare,
5 energy production and use, agriculture and food, our natural resource base, ecological
6 health, and transportation and community infrastructure. While historically each of these
7 issues has been managed in a discrete fashion, changing conditions require new
8 institutional arrangements to recognize and address linkages between diverse sectors.

9
10 The scope of these broader issues exceeds the authority, capabilities, and resources of any
11 single organization. For this purpose, NOAA proposes to initiate a dialogue with the
12 family of federal agencies, private sector, and other appropriate organizations to develop
13 a vision and guidelines for how our collective expertise and infrastructure can be
14 organized to address the climate challenge. Through continuous engagement, the full
15 capacity of the nation will be brought together to bridge the gap between the nation's
16 scientific and technical expertise and the emerging problems and needs of state, local,
17 and regional interests. Such a collaborative effort will move us far beyond individual
18 activities limited by what each agency can provide or access on its own.

19 20 **A Proposed National Climate Services Partnership**

21 ***Vision***

22 The vision is that a fully integrated partnership will lead to:
23

1 ***An informed society anticipating and responding to climate and its impacts.***

2
3 A successful climate services partnership will fully utilize the capacity of the nation's
4 climate enterprise to meet the challenges and maximize opportunities posed by climate
5 variability and change. User needs, identified through ongoing communication, will be
6 addressed through targeted tools and services and the development of reliable climate
7 information. Climate services are founded upon observing and monitoring Earth
8 systems (including ecosystems); focused research to understand key aspects of the
9 system's behavior and decision processes; and modeling capabilities for forecasting,
10 predictions, and projections across timescales. Climate services would also need to
11 include the development, assessment, and delivery of a range of communication tools,
12 processes, education, training, and outreach.

13
14 ***Mission***

15 The working mission statement for the national climate services partnership is to:

16
17 ***Guide the nation's climate mitigation and adaptation efforts through partnerships that***
18 ***bridge the gap between climate science and decision-making.***

19
20 By integrating capabilities, expertise, assets, and missions across federal agencies, the
21 partnership will collectively advance the nation's provision of climate services well
22 beyond what any single organization can provide. It will:

- 23 • bring together the nation's modeling, assessment, and prediction capabilities

- draw upon resources in Earth system science, economics, the social sciences, and ecology
- coordinate a nationally integrated, interagency approach to climate change education and communications

The partnership will rely on the expertise of resource managers as well as scientists and extension specialists in the

interpretation and communication of climate data and risk. In addition, a coordinated national climate services partnership will identify critical gaps in the nation's climate infrastructure that can be addressed using a national strategy to provide climate information and services on international, national, regional, and local levels.

Achieving the vision of “An informed society

Box A: Example – Water Resources

An integrated picture of water resource availability today and in the future requires improved observation and forecasting of changes in the frequency and intensity of precipitation events. This knowledge needs to be combined with detailed scientific information about streamflow, land cover and land use characteristics as well as changing societal and ecological demands. Similarly, water resource managers, land resource managers, community planners and the public will increasingly be required to share information and coordinate decisions in order to balance competing demands with resource availability. A shared focus on the sustainability of water resources under changing climate conditions will require an integrated suite of climate data products and information services. Those products and services will guide individual decisions and support the emergence of a societal capability to develop coordinated responses that are mutually supportive in the long-term.

In this context, an interagency partnership could involve:

- US Geological Survey (USGS) contributions related to streamflow and hydrological processes
 - NOAA contributions in climate monitoring and data records, seasonal-to-interannual predictions, long-term climate projections and assessments, regional socio-economic and decision support research, regional information services, and endangered species information
 - National Aeronautical and Space Administration (NASA) contributions from satellite-based missions and basic research on hydrological processes
 - Environmental Protection Agency (EPA) contributions in the area of water quality research and standards
 - National Science Foundation (NSF) support for basic research on climate and hydrological processes, socio-economic impacts and decision support science
 - US Department of Energy (DOE) efforts to improve models and understanding of ecological effects of climate change at a national and regional level; as well as other Federal agencies such as;
 - The US Army Corps of Engineers (Corps), Bureau of Reclamation (BuRec), and resource management agencies including US Department of Agriculture (USDA) [Forest Service (USFS), Agriculture Research Service (ARS), Natural Resource Conservation Service (NRCS)], Department of Interior (DOI) [National Park Service (NPS), Fish and Wildlife Service (FWS), Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM)], among others.
- Working together with private sector, non-governmental organizations, formal and informal learning institutions, this partnership could provide state and local resource managers and the public with an integrated picture of past, present and future climate conditions as they affect water resources.

anticipating and responding to climate and its impacts” requires a new level of collaboration among science, society, and organizations. That collaboration is necessary to provide a clear source of comprehensive and authoritative information across government, understand the consequences of climate variability and change, explore potential response options, and implement policies and programs to efficiently move towards a more resilient society. Examples of climate-sensitive issues and the multi-institutional resources available to address them are highlighted in Boxes A and B for water resources and coastal communities, respectively.

Insights gained from this new national climate services partnership will guide the development of climate products and services and inform future investments in an end-to-end climate information system that includes:

- global observations and the stewardship of valuable data

Box B: Example – Coastal Communities

Coastal communities need to enhance their resilience to successfully face increasing problems with coastal inundation due to the combined effects of sea level rise and changes in storminess including hurricanes and Nor’easters. One building block toward preparedness is an integrated understanding of how rainfall, water level and wind-driven waves interact to drive coastal inundation. Another important facet of preparedness is an enhanced appreciation for the environmental and societal factors that characterize a community’s vulnerability to these climate-related hazards. Coastal managers, land management agencies, economic development agencies, infrastructure planners and disaster managers will be required to work in close coordination to ensure that decisions on individual projects balance the needs of today while ensuring that these decisions do not increase exposure in a future that may bring greater risk. Supporting decision-making under these conditions requires a suite of information products and decision support tools that sets a detailed understanding of changing climate in the context of an enhanced understanding of changing societal and environmental conditions.

In this context, an interagency partnership might include:

- USGS data, research and modeling on shorelines, shoreline erosion, rainfall and streamflow as well as insights from the use of coastal vulnerability assessment tools
- NOAA observations, data, scientific insights on the primary physical drivers of coastal inundation including strong winds, high seas, heavy rains and other aspects of storminess, projections of how those conditions might evolve under changing climate conditions, coastal geodetic information, and insights on socio-economic vulnerability of coastal communities
- wave and coastal flooding observations and modeling from the Corps of Engineers
- the coastal hazards mapping programs of the Federal Emergency Management Agency (FEMA)
- DOE models and regional analyses
- Department of Transportation (DOT) for management of transportation system and effects
- EPA for wetlands management
- other land and resource managers (e.g., USFS, NPS, BuRec); as well as other agencies, private sector, non-governmental organizations and formal and informal learning institutions.

- 1 • historical and real-time monitoring of climate conditions
- 2 • research to improve understanding of the nature and consequences of changing
- 3 climate conditions
- 4 • development of improved Earth system models and predictive capabilities across
- 5 temporal and spatial scales
- 6 • assessments of the state of the climate system and the resilience of communities,
- 7 sectors, and natural resources to changing climate conditions
- 8 • problem-focused, user-driven data services, information products and decision-
- 9 support tools
- 10 • investments in climate awareness, capacity building, education and outreach
- 11 programs that enhance climate literacy

12

13 The scientific and management communities recognize the advantages of a

14 comprehensive federally organized effort in climate science and application. In some

15 cases, important collaborations already exist, but the network of alliances and working

16 arrangements required to achieve the depth and breadth of what is envisioned for a

17 national climate services partnership have not been established. Of particular importance

18 is the need to directly connect scientists, brokers of information, and decision makers

19 across sectors, disciplines, and levels of government. Ultimately, this national

20 partnership will provide a coordinating role across local, state, and regional climate

21 service providers to ensure an effective connection between services and local-to-regional

22 needs.

23

1 **Partnership Principles**

2 Partner agencies will come together to work through and develop agreed upon principles
3 for governance, operations, and expected outcomes. To be successful, the partnership
4 will require coordination at multiple levels to provide the necessary guidance and
5 coordination as well as working-level cooperation on specific programs and activities.
6 High-level coordination within the Executive Branch involving cabinet offices working
7 closely with the Office of Science and Technology Policy (OSTP), Office of
8 Management and Budget (OMB), and the Council on Environmental Quality (CEQ) is
9 necessary to ensure an integrated approach to policy decisions and budget planning while
10 providing departments and agencies with the required guidance to help shape their
11 individual contributions to the partnership as a whole. At the same time, implementation
12 of partnership activities will require government-wide mechanisms to utilize existing
13 resources, manage projects and programs, and track appropriations and results. This task
14 will require the sustained engagement of individual departments, agencies, and programs
15 as partners focused on both the successful implementation of individual climate service
16 program elements and their integration in the context of a shared vision. This
17 engagement will involve agency representatives with responsibility for the
18 implementation of their agency's climate services and the authority to make program and
19 project-level commitments to shared activities. The U.S. Climate Change Science
20 Program (CCSP) has played a similar role in coordinating climate science activities
21 across the federal government (e.g., the development of the 21 Synthesis and Assessment

Products³ and the forthcoming Unified Synthesis Product), and it has worked to develop products that assess the applicability of this science to decision making.

Working in collaboration with other agencies, nations, and the private sector is central to NOAA's climate observation strategy. For example, all of NOAA's contributions to global climate observations, such as the Global Climate Observing System (GCOS), are coordinated internationally in cooperation with a variety of international, regional, and bilateral partnerships. Support for the long-term deployment, operation, and improvement of the global climate observation system is necessary to drive, evaluate, and improve forecast models, and to document the changing state of the climate, including building capacity for data stewardship. A global observing system, by definition, crosses international boundaries, with potential for both benefits and responsibilities to be shared by many nations. Wide-ranging collaborative projects deal with climate prediction, ocean observation, stratospheric detection, water vapor measurements, capacity building and training, and communication of information, and they focus the attention and resources of these countries on developing a more sustainable and robust program.

Successful implementation of a national climate services partnership will require adherence to a set of principles that will support the emergence of a collaborative, multi-agency, and eventually, multi-national endeavor. While all partners will participate in the development of these principles, we propose the following as a starting point:

²²

³ <http://www.gcrio.org/library/sap-final-reports.htm>

- 1 • Capitalize on the unique capabilities, special expertise, and individual
- 2 responsibilities of partners in government, NGOs, academia, and the private
- 3 sector
- 4 • Ensure continuous and sustained dialogue between partners to understand
- 5 capabilities and identify climate-related risks that are of most urgent concern to
- 6 decision makers and the public
- 7 • Establish clear lines of responsibility regarding infrastructure, programs, and
- 8 activities
- 9 • Implement joint decision-making to establish and address partnership priorities
- 10 • Develop a single programmatic framework that effectively integrates the work of
- 11 individual institutions and programs within a set of shared goals and objectives
- 12 • Continuously infuse scientific and technological advances to ensure the
- 13 development of services based on the most advanced science available

14

15 **Proposed Next Steps**

16 NOAA presents this proposal to initiate a dialogue with partners. The ideas presented

17 here will be further developed and refined in collaboration with academic, governmental,

18 private, and non-governmental organizations. With this proposal, NOAA offers to

19 convene this dialogue by engaging the range of participating agencies and organizations.

20 NOAA's ability to assume this role would draw naturally upon the diverse capabilities

21 that it has developed as both a science and service organization demonstrated by

22 leadership in the implementation of the National Integrated Drought Information System

23 (NIDIS) and similar interagency projects. As in these activities, NOAA recognizes that it

1 does not represent all the expertise needed to address the myriad aspects of a changing
2 climate and its impacts, and it will, of necessity, look to partner agencies to bring together
3 the needed expertise, capabilities, and experience to identify and address emerging
4 climate-related risks and vulnerabilities. NOAA's capabilities are further discussed in
5 Part 2 of this document, as are details regarding the establishment of a National Climate
6 Service within NOAA.

7
8 To move the partnership forward, we propose the following next steps:

- 9
10 • Review past and current models of interagency climate program coordination (e.g.,
11 CCSP, U.S. Global Change Research Program (USGCRP), Office of the Federal
12 Coordinator for Meteorology (OFCM), as well as approaches used in other countries)
13 and develop recommendations regarding mechanisms to support the interagency
14 national climate services partnership
15
- 16 • Establish a cross-agency national climate services partnership design team. This team
17 would address the organizational complexity and breadth of activities in the
18 development of the partnership. It would consider options such as establishing a
19 Council of external advisors to ensure collaboration among partnership organizations
20 (e.g., federal and state agencies, non-governmental organizations, private sector,
21 academia, etc.), including ensuring that climate activities, within each represented
22 group complement the goals of a national service. A Council could also provide

1 guidance on key priorities for attention, ensure coordination across regional and
2 national concerns, and assess evolving information needs.

3
4 • Conduct an assessment across all levels of government to understand activities
5 underway that are focused on the management of climate-sensitive resources and the
6 knowledge systems that support them

7
8 • Elicit service and information requirements derived from mission agencies whose
9 regulatory and statutory responsibilities are affected by a changing climate

10
11 • Design regional pilot activities to identify and prioritize the nation's adaptation
12 challenges

13
14 • Engage end users (e.g. resource managers, decision makers, scientists, business
15 leaders, educators) of climate information and services by assessing their needs for
16 information

17
18 • Identify cooperative activities with international organizations and programs

19
20 • Design criteria for success such as expectations and outcomes for the partnership

Part 2. NOAA's Strategic Plan for a National Climate Service

Introduction

While the partnership described in Part 1 will draw on the capabilities and resources of agencies across government, a single entity is required to be accountable to build and sustain the services needed to support the nation's management and policy decisions.

This section outlines a path for NOAA to develop and implement such a National Climate Service. The plan includes a consolidation of NOAA's existing climate activities, transforming them into an integrated and comprehensive National Climate Service. Through the development of this National Climate Service, NOAA will leverage its strong research portfolio, monitoring and modeling capacity, and operational

infrastructure, along with the capabilities of the national climate services partnership to provide climate information and services to the nation.

NOAA's vision for a National Climate Service is shared with the partnership described in Part 1 and is one that leads to

"An informed society anticipating and responding to climate and its impacts."

The mission for this Service in NOAA is ***"to develop and deliver research, information, and services to enhance***

Guiding Principles for a National Climate Service

- Continuous and sustained dialogue with users to understand vulnerabilities, identify information and service needs, and inform priorities
- Capitalize on the unique capabilities, special expertise, and individual responsibilities of partners in government, academia, and the private sector
- A single programmatic framework that effectively integrates the work of individual institutions and programs in the context of a set of shared goals and objectives
- The continuous infusion of scientific and technological advances to ensure the development of services based on the most advanced science available
- A commitment to improve our understanding of past, present, and future conditions in climate, social, economic, and environmental systems in order to provide useful climate products and services to support decision-making
- Activities that enable users of climate information to address today's problems and plan for tomorrow
- Advanced information that links weather and climate time scales to enable effective planning for, and response to, extreme events in the context of a changing climate
- Recognize that natural and anthropogenic climate changes do not occur in isolation and the need to address these changes within their social, economic, and ecological context

1 *society's ability to understand, anticipate, mitigate, and adapt to climate variability and*
2 *change.”* This plan is aligned with NOAA’s overall mission “to understand and predict
3 changes in Earth’s environment and conserve and manage coastal and marine resources
4 to meet our nation’s economic, social and environmental needs.” As NOAA moves to
5 address its National Climate Service mission, it will build on a strong foundation of
6 existing capabilities, assets, and collaborations at international, national, and local levels.
7 In addition to addressing program considerations at the national level, it is of particular
8 importance to recognize the critical roles that local offices (e.g., NWS forecast offices)
9 and regional partners like the Regional Climate Centers (RCC), Regional Integrated
10 Science and Assessment programs (RISAs), State Climatologists, and others will play in
11 the implementation of a National Climate Service. Because many climate-related
12 adaptation decisions will be made at local or regional levels, NOAA recognizes the
13 importance of providing strong support for climate service activities at these levels. At
14 the same time, NOAA recognizes the need for strengthening the capabilities of national
15 centers like the Climate Prediction Center (CPC), the National Climatic Data Center
16 NCDC), and NOAA’s other science laboratories.

17 18 **Strategic Goals and Objectives**

19 The strategic goals and associated objectives of the National Climate Service summarized
20 in Table 1 reflect NOAA’s core capabilities in climate observations, research, and
21 modeling. These goals represent enhanced efforts in delivering services and products to
22 users and actively engaging partners. Woven into all the goals is the need to be

- 1 systematically responsive to evolving user needs in a changing environment and to
- 2 improve NOAA products and services.

3 **Table 1 Strategic Goals and Objectives for a National Climate Service**

<p>Goal 1: Provide Leadership for a National Climate Services Partnership</p> <ul style="list-style-type: none"> • Support an advisory council convened by a national climate services partnership • Coordinate and advance NOAA's climate service, partnerships with existing science, service and management organizations in support of a National Climate Service • Accelerate the transition of science and technology advances to climate information and services that are directly relevant to users • Manage and coordinate collaborative activities across local, state and regional climate service providers in order to ensure an effective connection between services and local to regional needs • Establish working relationships with private sector providers of climate information to optimize evolving capabilities
<p>Goal 2: Build and Sustain Comprehensive Observations and Monitoring Systems</p> <ul style="list-style-type: none"> • Provide the Nation with observations that are timely, reliable, high-quality, relevant, and easily accessible • Archive the Nation's climate-related data, models, and analyses and provide user-friendly access • Ensure the reliability, continuity, and integrity of the historical climate record through scientific data stewardship • Monitor climate variability, trends, and indicators to assess the state of the climate • Monitor and assess climate relevant atmospheric processes and constituent concentrations
<p>Goal 3: Provide State-of-the-Art Research, Modeling, Predictions, and Projections</p> <ul style="list-style-type: none"> • Conduct research to advance the understanding of climate forcings and processes, their role in past climate change and in the prediction and projection of climate, and the implications for social, economic, and ecological systems • Continuously improve the capability and capacity to model and predict the climate across temporal and spatial scales • Conduct analyses to provide timely explanations of the observed state of the climate system • Conduct research and assessments to enhance understanding of climate impacts and vulnerabilities and inform planning and policy formulation
<p>Goal 4: Develop, Deliver, and Communicate Valued Climate Services in Collaboration with Users</p> <ul style="list-style-type: none"> • Engage users and partners through a continuous dialogue to identify evolving climate information needs • Undertake issue-focused science and services in support of adaptation, preparedness, and mitigation • Work with internal and external users to identify and maintain the most effective methods of communication and delivery • Build capacity and provide training to access and use climate information and services • Develop training, education, and outreach activities to increase awareness, understanding of climate variability, climate change, weather-climate linkages, and their impacts • Build and integrate NOAA's work-force, infrastructure, and technology for continuous, dependable, valuable, and routine delivery of reliable climate predictions, information, and service • Evaluate and support continuous improvement of NOAA's delivery of end-to-end climate services

4

5 ***Goal 1. Provide Leadership for a National Climate Services Partnership***

1 Many Federal agencies contribute to a variety of aspects of climate services (Table 2);

2 however no single

3 agency can provide

4 all aspects of

5 climate services to

6 the nation.

7 Therefore, a

8 national climate

9 services partnership

10 is needed to

11 coordinate efforts.

12 However, for this to be successful, one single federal agency will need to take a

13 leadership role in implementing this partnership. This agency will be responsible and

14 accountable for ensuring coordination across the family of entities, federal and otherwise,

15 that will need to work together. NOAA is ready to step into this role.

16

17 NOAA's comprehensive climate mission extends from understanding climate variability

18 and change to producing, delivering, and applying climate information that helps society

19 plan and respond. NOAA houses a diverse wealth of experience – the nation's weather,

20 ocean, fishery, and satellite services – connecting users with environmental information.

21 The agency is well positioned to provide the core elements and central-coordinating

22 functions of the national climate services partnership.

23

Table 2: Federal Agencies and Climate: Some Examples*

X = Areas where agencies may engage in the exchange of climate information.

Agencies	Observations and Monitoring	Research, Modeling and Assessments	Resource Risk Management	Adaptation Mitigation
DOC	X	X	X	X
DOD	X	X	X	X
DOI	X	X	X	X
EPA	X	X	X	X
USDA	X	X	X	X
DOE	X	X		X
DOT	X	X		X
NASA	X	X		
NSF	X	X		
HHS		X		X

*This is an initial attempt to describe the multi-agency nature of Federal climate activities. This is meant to be illustrative only and does not represent a thorough review of agency programs and activities.

1 As the convener of a proposed national climate services partnership, NOAA would
2 support the partnership's advisory council and coordinate the contributions of the many
3 partners required to meet overall partnership objectives. Capitalizing on effective
4 relationships with Federal, academic, private, NGO, international, and other partners,
5 NOAA will work with its partners to identify user priorities, transition relevant scientific
6 advances to end-use applications, and ensure that critical services are provided in a
7 coordinated manner. In cooperation with several partners, NOAA will continue to work
8 to develop a climate literacy framework to advance public understanding of climate
9 science and support informed decision-making. Building on its experience in weather
10 services, NOAA will provide for private sector efforts to develop enhanced climate
11 information services from basic climate information.

12 13 ***Goal 2. Build and Sustain Comprehensive Observations and Monitoring Systems***

14 Observations are critical to understanding Earth's climate system, improving climate
15 predictions and projections, monitoring current climate variations and trends, assessing
16 the state of the climate system, understanding impacts, and placing them into proper
17 historical context. A comprehensive suite of integrated *in situ* and remotely sensed data⁴
18 is required to describe the climate with sufficient fidelity to confidently address the needs
19 of its users and to fulfill legal mandates. Existing and planned observing and monitoring
20 systems must be capable of delivering not only the rate of climate change at global and
21 regional scales, but also the change in the rate. This places new requirements on existing
22 observing and monitoring capabilities. While no single agency or entity can provide all of

22

⁴ All data are collected and stored consistent with national and international standards.

1 the capabilities that are needed, NOAA's extensive array of climate observing assets and
2 routine climate monitoring products are keystones of the partnership. Maintaining and
3 improving state-of-the-art global Earth observing and monitoring systems, developing
4 capabilities for data management and stewardship, and coordinating effectively with
5 other participants in the national climate services partnership, are important aspects of
6 this Goal. Data management includes services for secure archive and easy access to
7 climate data records. Interoperability and standardization of data are critical for ease of
8 use. Consolidation and integration of the available data into user-friendly formats are
9 especially critical. Stewardship of the long-term data record will ensure the reliability,
10 accessibility, and excellence of fundamental climate information. Collectively, these
11 activities ensure that NOAA can provide a rigorous analysis of the historical climate
12 record and a comprehensive description of the current state of the climate in the context
13 of the historical record to support decision-making.

14 ***Goal 3. Provide State-of-the-Art Research, Modeling, Predictions, and Projections***

16 An overarching goal of climate research and modeling is to advance understanding of
17 Earth's climate system including climate variability, the quantification of climate
18 forcings and processes, and the role of the ocean, atmosphere, cryosphere, and biosphere.
19 That understanding is essential to develop the capacity and capability to make skillful and
20 reliable predictions and projections of climate variability and change at relevant spatial
21 and temporal scales. A key requirement for predictions and projections is process
22 research leading to the development of more comprehensive and accurate models. To
23 make predictions and projections on longer time-scales, Earth system models must

1 accurately incorporate sea ice, ice sheet dynamics, the carbon cycle, and other relevant
2 dynamic and thermodynamic, physical, chemical, and biogeochemical processes.

3 Providing this research and modeling to improve prediction will be an essential goal of
4 the National Climate Service.

5
6 Just as important as modeling, understanding, and predicting physical climate variability
7 and change is the research, assessment, and prediction of the impacts of climate on
8 vulnerable communities and resources. It is critical to develop a more integrated Earth
9 system analysis capability. This capability would allow the reconstruction of the
10 historical climate including the causal factors. It would allow addressing future issue-
11 focused climate and management needs, as well as focused model and observation-based
12 research on attribution of current events. As stated in the IPCC Fourth Assessment
13 Report, "Most of the observed increase in global average temperatures since the mid-20th
14 century is very likely (95% confidence) due to the observed increase in anthropogenic
15 greenhouse gas concentrations."⁵ However, there is a need to better attribute observed
16 changes, e.g. drought, sea level rise, and melting sea ice and permafrost, to clearly
17 identify the impacts of a changing climate. To help meet this goal, NOAA will expand
18 research, analyses, and assessments to understand the implications of a changing climate
19 for social, economic, and ecological systems. NOAA will provide that information to
20 resource managers, other agencies, and policy- and decision-makers.

20

⁵ IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

1 ***Goal 4. Develop, Deliver, and Communicate Valued Climate Services in Collaboration***
2 ***with Users***

3 A service, by definition, is responsive to users on a daily and sustained basis. NOAA
4 will emphasize effective communication with its partners and users and evaluate its
5 ability to identify and understand their climate data, applications, and science needs. To
6 do this, a National Climate Service will need to support and facilitate a multi-directional
7 flow of data, information, and

8 knowledge. In addition, issue-
9 focused (e.g., water resources,
10 ecosystems, coasts) observations,
11 research, and assessments will be
12 required to support local, state,
13 regional, national, and international
14 options for both mitigation and
15 adaptation in the public and private
16 sectors (see example in Box 2).

17 This will often require multi-
18 disciplinary investigations into
19 climate and the integration of

20 information in a context that is meaningful to those responsible for planning and policy
21 formulation. One early opportunity involves building on NOAA's longstanding
22 collaboration with national, state, and local disaster management agencies in the context

Box 2 - The National Integrated Drought Information System (NIDIS)

NIDIS is a mechanism to deal with drought in response to the Western Governors Association and the NIDIS Act of 2006. Through interagency participation (federal and state agencies, local government, regional and state climate offices, and academia) in the NIDIS Planning and Implementation Team, NIDIS is positioned to build on successes of the U.S. Drought Monitor, Seasonal Outlooks, and other experimental and operational tools. The success of these programs supports a greater coordination of relevant monitoring, forecasting, and impact assessment efforts at national, watershed, state, and local levels. The closer coordination of such programs provides a better understanding of how and why droughts affect society, the economy, and the environment. This allows for improved accessibility, dissemination, and use of early warning information for drought risk management. The scope of early warning activities include (i) education and public awareness, (ii) integration of monitoring and forecasting, (iii) interdisciplinary research and applications for risk assessment, (iv) engagement of the preparedness communities, and (v) the web-based drought portal for improving accessibility to usable drought risk information. This approach provides a mechanism to identify and then close the gaps between what is available and what is needed for proactive drought risk reduction. NIDIS relies on coordinating the existing network of disparate climate services experiments (see RISAs) and operational entities (NWS Climate Observations and Services, NOAA's Regional Climate Centers, and the USDA Agricultural Extension)

1 of hazardous weather risk management to support the emergence of an effective climate
2 risk management community for the nation.

3
4 In addition to developing an issue-focused observing, analysis, research, modeling,
5 prediction, projections, and assessment capability, NOAA will enhance its existing set of
6 diverse delivery mechanisms. Such an enhancement will improve the transition and
7 communication of these observations, analyses, research, and assessments into climate
8 science, information, products, and services that inform and support decision-making and
9 problem solving. Well-informed user groups and a public that is capable of utilizing
10 National Climate Service products and services are necessary to achieving the mission of
11 the Service. The ongoing engagement of users to understand the information needs for
12 the reduction of emissions (mitigation) and adaptation to unavoidable climate impacts has
13 provided, and will continue to provide, insights on how to link these two strategies. Such
14 a linkage should include impacts at all climate timescales to ensure short-term decisions
15 do not undermine or conflict with longer-term adaptation options (e.g., does not decrease
16 adaptive capacity nor contribute to making the overall problem worse). Furthermore,
17 dealing with these issues across the time scales of climate variability from extremes, to
18 seasonal to interannual and decadal, has provided critical entry points for involving users
19 in framing service requirements to inform and support longer term mitigation and
20 adaptation plans for responding to climate change. Accordingly, NOAA will build user
21 capacity to understand and apply NOAA models, data, tools and services that enable
22 informed decision-making. Finally, NOAA will evaluate (both internally and externally)
23 its partnerships to conduct outreach as well as the utility of the data, information, and

1 products provided by the National Climate Service and improve those products and
2 partnerships based on those evaluations and feedback.

4 **Toward a National Climate Service**

6 Understanding and developing capabilities to meet emerging demands for climate
7 information is the primary driver for NOAA's development of a National Climate Service
8 (see Box 3). Through this service, timely and reliable climate information and products
9 will be provided to help users anticipate, plan and respond appropriately to potential and
10 ongoing impacts of changing climate conditions. In the sections that follow the
11 transformation of NOAA's current climate activities into a National Climate Service is
12 examined using the strategic goals and objectives identified in the previous section. The
13 emerging demands are examined and NOAA's current capabilities to meet these demands
14 are reviewed. The justification for expanding these capabilities into a National Climate
15 Service is addressed. The strategic goals and objectives are used to describe the
16 emerging needs for a National Climate Service to meet the growth in demand. Finally,
17 the path forward from current capabilities to a National Climate Service is described with
18 both near-term and long-term steps.

20 ***Emerging Demands for Climate Services***

Government agencies, private sector interests, and communities throughout the nation and the world are increasingly aware of the consequences of changing climate conditions for their interests and increasingly driven to develop effective responses to manage the associated risks and/or capitalize on opportunities. Public and private entities want to understand how their activities impact Earth’s climate and vice-versa, including the possibilities of extreme changes and abrupt shifts in climate. Local, regional, and state entities require information to understand how their localities are contributing to, will be affected by, and can adapt to a changing climate. State and federal agencies are asking how changes in climate will affect their missions and how they can reduce vulnerabilities and make decisions in advance of problems based on a range of options. Users of climate information want to know how climate will change in their region leading to requirements for much higher resolution, skill, and breadth of information than currently available. For example, an emerging requirement from utilities and local governments is a prediction capability on the multi-decadal time-scale and global to local spatial scales, which will influence future infrastructure design and utilization decisions.

**Box 3 - Unmet Demands for Climate Information:
Some Examples**

"We need federal policies and funding that will enable local communities to identify their vulnerabilities in the face of the climate disruption, and that will support local efforts to minimize, prepare for and adapt to these impacts." (US Conference of Mayors, 2007)

Land managers in Western states are dealing with more severe drought impacts than in the past and are requesting long-term regional temperature and precipitation data, along with easily accessible and understandable tools for decision support (Western Governors’ Association, 2004).

A broad scope of industries face operational challenges due to climate change, including utilities, integrated oil and gas, mining and metals, insurance, pharmaceuticals, building and construction, and real estate (February, 2007 Lehman Brothers report, “The Business of Climate Change: challenges and Opportunities”).

Regions and municipalities need local information about climate change to improve long-term decision-making and research on climate change on these scales must be done to meet these demands (US Conference of Mayors, National Governors Association, World Climate Research Program).

1 External drivers include demands from local user groups, and recommendations from
2 various external bodies. Specifically, the August 2007 GAO Report, entitled “Climate
3 Change: Agencies should Develop Guidance for Addressing the Effects on Federal Land
4 and Water Resources,” asks NOAA to take climate into account when acting on behalf of
5 the U. S. Department of Commerce (DOC) as a trustee for coastal and marine resources.
6 The Coastal States Organization’s (CSO) report “The Role of Coastal Zone Management
7 Programs in Adaptation to Climate Change” analyses the role of coastal zone
8 management in addressing the impacts of a changing climate. The National Research
9 Council’s (NRC) decadal survey, “Earth Science and Applications from Space: National
10 Imperatives for the Next Decade and Beyond,” highlighted Earth observation needs
11 including those from a climate perspective.

12
13 Additional specific evidence of these emerging requirements for climate information
14 services can be seen in a number of public policy arenas:

- 15
16 • Congress is exploring the dimensions of climate change including consideration of
17 energy policy, changing climate science requirements, and the need for national and
18 regional climate services
- 19 • Mission agencies, and Federal resource managers in NOAA, DOI, and the USDA
20 Forest Service and others are considering the impact of climate change on their
21 statutory obligations⁶

21

⁶ August 2007 GAO Report, “Climate Change: Agencies should Develop Guidance for Addressing the Effects on Federal Land and Water Resources”

- 1 • States are responding to requirements for climate change mitigation and adaptation
2 through legislation, policy commissions, and statewide initiatives that integrate
3 climate change information into disaster management, resource management and land
4 use planning. Local governments are similarly augmenting planning bodies to
5 include consideration of climate change in their deliberations
- 6 • Businesses in sectors such as transportation, insurance, energy, fisheries management,
7 and agriculture are increasingly incorporating considerations of climate variability
8 and change in both near-term decisions and long-term planning
- 9 • Decision-makers and planners are looking for information on specific issues such as
10 drought, coastal impacts, ecosystem impacts, and hazards
- 11 • There is growing demand for sector-specific information related to sectors like health,
12 agriculture, and urban areas
- 13 • The public is showing a greater interest in understanding the impacts as evidenced in
14 the media and through a growing volume of requests for information

15
16 NOAA, too, has a broad range of resource management responsibilities. Its coastal and
17 marine resource managers will be important users of climate information and partners in
18 the National Climate Service. Among its numerous management responsibilities, NOAA
19 implements federal marine fisheries management under the Magnuson-Stevens Fishery
20 Conservation and Management Act, ocean use under the National Marine Sanctuaries
21 Act, marine mammal management under the Marine Mammal Protection Act, endangered
22 species management under the Endangered Species Act, and coastal management under
23 the Coastal Zone Management Act. Under each of these mandates, NOAA managers

1 must account for the effects of climate variability and change on coastal and marine
2 ecosystems and resources, and adapt their management practices accordingly. Changing
3 climate conditions, including ocean temperatures, ocean acidity, sea level, sea ice, ocean
4 current patterns, freshwater supply, and extremes in atmospheric conditions, impact
5 coastal and marine ecosystems. Information on these changes is required to improve the
6 management of these natural resources.

7
8 The National Environmental Policy Act (NEPA) is a legal mandate for improved climate
9 information in the context of natural resource management. Under NEPA, all reasonably
10 foreseeable environmental impacts must be accounted for in a proposed federal action.

11 Because the courts increasingly consider climate change a serious and well-recognized
12 threat, NOAA must now address climate change effects in the course of its proposed
13 regulatory actions. This mandate will require significant new information on the likely
14 effects of climate change on NOAA-managed resources and the management practices of
15 partner agencies.

16
17 To address their information needs of today and into the future, all climate information
18 users are faced with a large set of sources for climate information, but unfortunately it is
19 disaggregated, distributed, sometimes inadequate, and, occasionally provides conflicting
20 information. To address the growing demands and requirements for information, an
21 integrated and consolidated approach to the development, dissemination and use of
22 climate information products and services is needed.

1 ***Existing NOAA Capabilities***

2 NOAA has a suite of successful, but segregated, climate information capabilities and
3 delivery mechanisms, developed in close coordination with its partners and users. These
4 capabilities begin to address the strategic goals and objectives of the service. Individual
5 NOAA programs and organizations provide a strong foundation on which to build the
6 kind of integrated climate information service that will support society's efforts to
7 address today's problems while planning for the future. The key to achieving the
8 National Climate Service vision will be to bring these capabilities together and enhance
9 them in innovative new ways to provide an integrated service that is greater than the sum
10 of the existing parts.

11
12 The mission of the National Climate Service is an end-to-end endeavor focused on
13 informing decision makers through a predictive understanding of the global climate
14 system. This would require "translating" scientific knowledge into climate information,
15 products, and decision support resources that the public can incorporate into adaptation
16 and mitigation decisions. These outcomes will be achieved through a set of core activities
17 within each strategic goal, which draw upon existing or planned capabilities within
18 NOAA. Current NOAA capabilities that will contribute to meeting the National Climate
19 Service strategic goals are outlined below.

20
21 NOAA has a history of longstanding agency leadership in national climate programs.
22 Currently, NOAA leads international efforts for climate observations and monitoring,
23 research and modeling, and assessments and services. NOAA provides leadership and

1 secretariat support for the USGCRP in the form of the CCSP. It participates in achieving
2 the objectives of the US Group on Earth Observations (USGEO) and the OFCM. NOAA
3 plays a central role in the US contribution to the IPCC and provides research and support
4 for the International Ozone Assessment, a product of the Montreal Protocol. In addition,
5 NOAA has an extensive and robust distributed service infrastructure to provide routine
6 production and delivery of climate data, forecasts, information and services both
7 nationally and internationally. NOAA promotes climate and environmental literacy
8 through education and outreach initiatives.

9

10 NOAA maintains most of the nation's sustained climate observing networks, including
11 operational satellites, integrated atmosphere, ocean, and Arctic observations, and
12 networks for monitoring greenhouse gases, aerosols, and ozone. It depends on partner
13 agencies for other sustained observations, such as ground-based water information from
14 DOI, and space-based research measurements from NASA's satellite systems. NOAA is
15 authorized to maintain the nation's large active archive of weather, climate, and
16 oceanographic data through its data centers, which also host the World Data Centers for
17 Meteorology, the World Data Center for Paleoclimatology, and the World Data Center
18 for Oceanography. The data and information archived by NOAA are available to NOAA
19 and non-NOAA institutions for use in research, modeling, monitoring, forecasting,
20 prediction, and assessment. NOAA ensures the continuity and integrity of the historical
21 climate record through data stewardship. Finally, NOAA provides analyses of the
22 observed records, including the nation's climate statistics, and reanalysis of observations,

1 which strive to improve our understanding of the climate of the past century using a self-
2 consistent analysis.

3
4 NOAA carries out and supports a broad array of world-class research and modeling
5 capability, which supports a growing operational prediction system. It extends from
6 Earth system research activities to improve understanding of past and current climate
7 states and the influences of natural and human-induced causes. It includes research and
8 transition activities that accelerate developments in operational coupled climate models
9 used for predictions and projections. NOAA works to develop and deliver weather, water,
10 climate and space weather guidance, forecasts, warnings and analyses. Internal NOAA
11 collaborations ensure consistent delivery and dissemination of NOAA climate forecasts
12 and information. NOAA develops Earth system models for prediction and projection for
13 national and international climate variability and change research and assessment efforts.
14 NOAA conducts regional studies of climate impacts for numerous sectors, including
15 water resources, marine ecosystems, and agriculture. It carries out issue-focused research
16 and applications development, including: projections of large scale changes in
17 atmospheric chemistry, and experimental predictions and projections of the future state of
18 the climate arising from natural variations and human-induced factors. Additionally,
19 NOAA supports research activities that merge the physical, social, and economic
20 sciences for a comprehensive approach to provide information to the broad range of users
21 of its products and services.

1 In collaboration with users, NOAA supports applications development to respond to their
2 needs. NOAA serves the broad user community of resource decision makers by
3 providing, among other things, operational climate forecasts, decision support
4 information and coastal resource planning and management. In addition to the routine
5 delivery of week- to seasonal to interannual climate forecasts and related information
6 support services, NOAA also provides monitoring and assessment products, such as the
7 Drought Monitor and the U.S. Hazards Assessments. In response to issue focused needs,
8 NOAA is developing issue-oriented services. As of 2006, NOAA was authorized by law
9 as the lead agency in the implementation of the inter-agency National Integrated Drought
10 Information System (NIDIS), which provides an integrated objective drought monitoring
11 and forecasting system. NIDIS engages users in the development of products to support
12 risk assessment, forecasting, and management. NOAA has an established history of
13 climate information and service delivery through its existing network of “first
14 responders” on the international, national, regional, and local levels (e.g. NWS Weather
15 Forecast Offices, NWS River Forecast Offices, RISAs, the International Institute for
16 Climate and Society, the Coastal Services Center, RCCs, regional collaboration teams,
17 Sea Grant, extension agents, communicators, and educators). These activities provide
18 regional and local coordination to establish and maintain a dialogue with users on the
19 relevance of existing products and services, and to solicit input for enhancing NOAA’s
20 capabilities to develop, deliver, and communicate climate services. The Pacific Climate
21 Information System (PaCIS) and the Pacific Region Integrated Climatology Information
22 Products (PRICIP) are two of many examples of NOAA-wide activities that work with
23 NOAA’s partners (e.g. Universities, agencies, users) to develop and deliver, in direct

1 response to stated needs of coastal managers and disaster management officials, climate
2 services in a specific region. These examples highlight how NOAA is already moving
3 towards an integrated, agency-wide climate services approach in concert with its
4 collaborators in other agencies and the core user community.

6 *An integrated approach to a National Climate Service*

7 A National Climate Service is needed to enable decision makers to manage the risks
8 associated with changes in climate. Without an integrated service, policy and decision
9 makers will be challenged to make informed decisions with a distributed, independent,
10 and often inadequate set of national climate information resources. The previous section
11 identified a portfolio of successful but mostly autonomous NOAA climate related
12 activities in observations and monitoring, research and modeling, decision support, and
13 service delivery. NOAA will need to organize its resources and integrate them with those
14 of its partners to ensure that the future delivery of climate services is transparent and
15 seamless for the users of this information. The demands for integrated and enhanced
16 climate information products to anticipate, mitigate and adapt to changing conditions
17 presents NOAA with the requirement to undertake two essential actions. The first is to
18 identify critical scientific, programmatic, and delivery gaps in existing activities. The
19 second is to develop a new internal organizational approach designed to build on these
20 current and emerging capabilities to create a truly integrated climate service.

21
22 Climate variability and change impacts national and local economic and societal goals
23 within, and across, sectors including, water, energy, health, agriculture, ecosystem

1 management, and the coastal zone. Integrated resources management (e.g. water, coastal
2 zone, ecosystem) provides an important framework to support successful adaptation
3 measures across socio-economic, environmental and administrative systems. As
4 experience across NOAA has shown for integrated approaches to be effective, they must
5 be coordinated at the appropriate scales (e.g., local, watershed, national) needed to
6 facilitate early warning and successful actions for specific outcomes (e.g. irrigation,
7 hydropower, endangered species recovery, recreation). Developing and communicating
8 climate and climate impacts information is a critical emerging need. This information is
9 necessary to inform adaptation and mitigation plans integrated across sectors (Box 4).
10 Examples include water quality, aquatic ecosystems, groundwater, and their socio-
11 economic dimensions. A climate service would bring together the supporting
12 infrastructure needed to develop, conduct proofs-of-concept, evaluate and disseminate
13 climate data, information, and tools. Such a climate service would facilitate integrated
14 appraisals of adaptation and mitigation options across multiple sectors and across an
15 appropriate user-focused ensemble of near and longer-term future climates.

1 NOAA embraces the
2 challenge of integrating and
3 improving its capacity to
4 meet the current and future
5 service needs of different
6 user groups for climate
7 information. An
8 understanding of the needs of
9 each user group will enable
10 NOAA to maximize the value
11 of the climate products and
12 services it develops and
13 delivers. NOAA has been
14 working directly with users
15 to: assess current and future
16 needs for climate
17 information; describe and
18 prioritize needs for climate services; identify focused areas of demand; aggregate and
19 prioritize information needs based on capabilities; establish pathways for continuous
20 feedback from current/future users. This approach allows it to be flexible and responsive
21 to overlapping and changing needs of the ever-growing user base. NOAA has worked to
22 understand which groups have similar perceptions, needs, and responses to specific
23 climate service lines.

Box 4 – Issue focused example: Coastal Climate Services

The need: Over half of the nation’s population lives within the 20% of the land area that is defined as coastal. These coastal counties also generate approximately 60% of the nation’s Gross Domestic Product (GDP). Over the past 30 years, nearly 70% of the US repetitive flood losses occurred in coastal areas, largely associated with storm surge, coastal inundation and erosion. Without mitigation and adaptation strategies, acceleration of sea level rise (SLR) over the next few decades will greatly exacerbate these losses.

NOAA’s Foundation: Over the past seven years, NOAA’s National Ocean Service (NOS) has worked broadly with others across NOAA to improve understanding of and the ability to reduce or avoid impacts associated with coastal extreme events. Through this cross collaboration (e.g. Regional Forecast Centers, National Centers for Environmental Prediction (NCEP), NCDC, RISAs, Sea Grant, National Estuarine Research Reserves (NERR)) improvements have been made: tide, water level and vertical reference observing systems modernized; high resolution coastal mapping expanded; improved coastal flooding models; models and forecasts available for use within Geographic Information Systems (GIS); pilot coastal climatologies funded; and local coastal inundation visualization and training tools developed.

There are increasing calls for expanded coastal climate impact assessment and adaptation tools. Calls are included within recently introduced climate bills and the proposed reauthorization of the Coastal Zone Management Act as well as state coastal programs for which “hazards and climate” is a high priority area of concern. Over the next few decades, billions of dollars will be spent upon public infrastructure investments (e.g. roads, sewers/water supply, transmission lines, and schools) within high hazard coastal areas. Incorporating climate information and tools into coastal planning can and will have a dramatic impact upon both the site and design of these high value assets. The same tools will support strategic approaches towards coastal habitat restoration and creation essential to protect vital ecosystem services, e.g. floodwater retention, biological productivity. Building upon agency wide capabilities, NOAA can work with its partners to develop the appropriate scale information and tools that will support coastal entities in their future planning.

Existing relationships and pathways of information provision and access are critical starting points as NOAA works to understand the interest and capabilities of future partners and users. NOAA will continue to work with both the providers and users of environmental information to define and implement a National Climate Service. To address any given issue NOAA and its partners will bring specific tools, capabilities, and assets to the table so they can be integrated and focused to solve problems. These partners will include other federal agencies, tribal governments, interagency task forces, regional councils, state agencies, state task forces, municipalities, universities, non-governmental organizations, international agencies, the private sector, and other nations.

As NOAA focuses on integrating and enhancing its climate science and service capabilities, as well as expanding its scope to address emerging demands, new relationships with partners and users will evolve. The efficiency, accountability, and transparency of NOAA's climate products and services will be improved through research, process optimization and user satisfaction assessments. In this way NOAA will ensure its users receive a high quality, integrated climate service meeting their needs for climate information across all time and space scales.

Addressing the Emerging Requirements

The establishment of a climate service that provides society with the information needed to anticipate, mitigate and adapt to changing conditions will require significant improvements to several existing NOAA capabilities. The vision, mission and goals of

1 this plan provide the strategic framework for integrating these capabilities. To produce
2 the needed climate information, research, modeling, data, products, and services to users,
3 improvements to and expansion of the existing global climate observation systems are
4 required. Examples of the enhancements needed to respond to this challenge follow.

5
6 *Build and Sustain Comprehensive Observations and Monitoring Systems*

7 NOAA currently, with other federal and international agencies, contributes to *in situ* and
8 satellite systems for the ocean, atmosphere and also recently the development of the
9 Arctic Observing Network, all following the implementation strategy of the Global
10 Climate Observing System (GCOS). NOAA needs to continue to work with its partners
11 to:

- 12 • Complete and maintain the in situ and space-based elements of the global climate
13 observing network
- 14 • Improve stewardship and consolidate archiving of data, including the
15 development of high quality climate data records and increases in the resolution,
16 comprehensiveness, and timeliness of climate data and information
- 17 • Integrate and analyze existing data from observing networks to develop an
18 ongoing comprehensive description and assessment of the changing state of the
19 climate system

20 These improvements will help with the development of a comprehensive integrated
21 approach for climate observations and monitoring to improve data and information on
22 global to local scales now and as climate challenges arise in the future.

1 Improving access and use of existing NOAA weather and climate data networks and
2 developing a focused point of entry for users to these networks are vital. NOAA needs to
3 integrate its numerous existing data archives through a single web-based point of access
4 for users, which will provide links to the national observing network.

5
6 *Provide State-of-the-Art Research, Modeling, Predictions, and Projections*

7 NOAA will continue to improve its understanding of climate processes through research,
8 observations, and monitoring. A better understanding of these processes will reveal the
9 implications for social, economic and ecological systems. Another focus for improvement
10 is the development of models that enhance the understanding of the role of natural
11 variations and human-influenced factors in the prediction and projection of climate.

12 NOAA will also need to provide more issue-focused and user-driven research efforts to
13 address emerging areas of concern and be responsive to internal and external user
14 demand for information. This will enable NOAA to expand its current capabilities to
15 provide timely explanations of the climate system through analysis and attribution, and
16 provide more regional, local, and sector specific information. The National Climate
17 Service will support appropriate basic research, as well as depend upon the efforts of its
18 partners in the USGCRP and international partners such as the World Climate Research
19 Programme, and the International Geosphere-Biosphere Program, which may lead to
20 scientific and technological breakthroughs to improve our understanding of the climate
21 system.

1 Computational resources are the primary limitation to the further development and
2 resolution of Earth system modeling, prediction, and projection. Manpower resources are
3 needed to build more comprehensive models and improved projection and predictive
4 abilities of models at all time and space scales. Another gap in the models' ability to
5 make reliable predictions is insufficient data availability, especially ocean and marine
6 ecosystem data, to initialize, assimilate, and validate models. Addressing these gaps will
7 enable NOAA to test complex high-resolution models and enhance the skill and
8 reliability of climate prediction across timescales. It would also support the development
9 of comprehensive coupled Earth system models that provide improved prediction and
10 projection information on issues like hurricanes, sea level rise, droughts, floods, and
11 regional hydrology.

12
13 Enhancing research and modeling capacity is essential to the National Climate Service, in
14 particular to infuse and accelerate the development and delivery of useful products and
15 services. A national climate modeling strategy should be developed to improve the
16 coordination and efforts of various data, and modeling and prediction centers as well as
17 research laboratories nationally and internationally. This will serve to focus evolving
18 modeling efforts, address computational resource needs on a national scale, and increase
19 collaboration among modelers and other scientists. NOAA can begin to address this gap
20 through better integration of its existing research and operations modeling centers (e.g.
21 Geophysical Fluid Dynamics Laboratory (GFDL) and National Centers for
22 Environmental Prediction (NCEP)) and by developing a strategy to coordinate with other
23 national and international centers involved in climate modeling activities.

Develop, Deliver, and Communicate Valued Climate Services in Collaboration with Users – To be responsive to user demands for climate information on a sustained basis and to begin to provide targeted services to users within and outside of NOAA (see example in Box 5), NOAA needs to integrate, strengthen and regularize its services through enhanced interactions with partners and users. It needs to build upon its current operational predictions provided to the public as well as its delivery of routine information products to the public. In addition to its national broad-based climate information products, NOAA will need to conduct assessments and synthesize climate impact information around user-driven issues (e.g. drought, coastal inundation, ecosystem impacts, and extreme events) as well as the broader spectrum of issues related to climate variability and change including their impacts on society and ecosystems. This will allow NOAA to develop and provide more useful, issue-focused information and services such as assessments and decision support tools related to climate impacts and near-term challenges resulting from climate variability and change, scenarios of the future, and adaptation and mitigation options.

Strengthening NOAA’s delivery mechanisms will improve the transition and communication of climate science

Box 5 - Climate and Living Marine Resource Management

Climate change will significantly impact U.S. marine ecosystems and the NOAA-managed resources that live in them. In one ecosystem – the Bering Sea – climate information is now being used in the management of pollock, the nation’s largest fishery. In 2008, the North Pacific Fishery Management Council reduced the Bering Sea pollock total allowable catch (TAC) by about 30%. This was based in part on climate information provided by NOAA that indicated warmer ocean conditions were thought to be unfavorable for pollock production. This is one of the only examples of climate information being used to set harvest guidance for a U.S. fishery.

A National Climate Service will help adapt the management of more U.S. living marine resources to a changing climate. By providing routine climate indices for the 10 U.S. large marine ecosystems, the National Climate Service would be providing information necessary to help sustainably manage the more than 900 populations of marine animals under NOAA’s jurisdiction.

1 information and services to NOAA's internal and external users. The provision of new
2 climate science information and services will help inform and support decision-making
3 and problem solving on international, national, regional and local levels. In addition to
4 improving delivery mechanisms, NOAA needs to build user capacity to increase the
5 understanding and improve the utility of climate data, tools, and services. To increase
6 public awareness of climate variability and change and its impacts, NOAA's science and
7 services will need to directly support the development of national education and outreach
8 activities. Finally, as part of this process of improving NOAA's delivery of climate
9 information and services, it will be important for NOAA to routinely evaluate (internally
10 and externally) the impacts on society of the information and products provided by the
11 service.

12
13 In parallel with efforts to refine and enhance existing observations, data stewardship,
14 research, assessment and delivery capabilities, NOAA will also need to address emerging
15 societal needs. Those emerging societal needs will be met through the building of the
16 national climate services partnership, making research operational, and enhancing
17 NOAA's existing regional networks and relationships. Whether the resulting
18 organizational structure will be a single mechanism, framework, or entity, will have to be
19 determined, but experience has shown that the existing virtual arrangement for climate
20 services will not effectively achieve the four strategic goals. Overarching issues for the
21 National Climate Service include a continued emphasis on increasing and sustaining
22 NOAA's own talent pool for the science, applications, communications, and delivery
23 tasks that will make up the Service. NOAA will also need to invest in its infrastructure

1 and technology to ensure success in addressing the numerous emerging needs in both the
2 near and long term.

3 4 **Next Steps**

5 6 ***Short-term recommendations (1 year)***

7 The following are short-term recommendations that will help NOAA begin the process of
8 addressing the gaps identified above to move toward a National Climate Service, and
9 work with its partners to lead the development of a national climate services partnership.

10 These short-term recommendations are supported through pending Congressional
11 legislation and NOAA's response to the GAO report. The most critical step will be to
12 identify the specific requirements for a National Climate Service. The recommended
13 short-term action items for NOAA to take in building a National Climate Service are:

- 14
15 • Document and review requirement drivers for a National Climate Service which
16 includes observations, data access, products, understanding, process level
17 research, predictions, projections, assessments, education, and user
18 communications. Use these requirement drivers to help evaluate options for
19 organizational approaches
- 20 • Conduct knowledge, service, and management assessments to identify climate
21 information and users' service needs
- 22 • Build a prioritization process to address the gaps in NOAA's current capabilities
23 to respond to emerging demand

- 1 • Initiate a process for regular communication and coordination with partners from
2 federal agencies, states, tribal governments, non-governmental organizations, the
3 private sector and the academic community through a series of workshops
- 4 • Begin to develop a long-term government-wide planning, requirements, and
5 funding strategy to implement and sustain the national climate services
6 partnership plan
- 7 • Design two to three pilot programs to test proof-of-concept for region-specific
8 and/or issue-focused services

9

10 ***Long-term recommendations (5 year)***

11 Understanding climate variability and change is a near-term as well as a long-term
12 challenge and NOAA will have to form an ongoing long-term plan to develop and
13 improve the capacities that support a National Climate Service. Some long-term
14 recommendations for such a plan are to:

15

- 16 • Implement long-term planning and programming strategies within NOAA that
17 support the National Climate Service mission
- 18 • Develop a science plan based on current assessments of climate information and
19 service needs that addresses major research gaps and prioritizes future research
20 efforts
- 21 • Support competitive research programs that will improve elements of the National
22 Climate Service and address critical needs in the science plan

- 1 • Evaluate existing critical climate information needs within NOAA to inform
2 future programs that will have to adapt NOAA's resource management
3 responsibilities to a changing climate
- 4 • Develop a strategic plan for the deployment and operation of the next-generation
5 global observation and monitoring system, including building capacity for long-
6 term data stewardship
- 7 • Establish a national modeling strategy to advance and coordinate climate
8 modeling and prediction capabilities through engagement and coordination with
9 external groups
- 10 • Improve communication of climate information and dissemination of climate
11 services on an on-going basis to the public
- 12 • Improve integrated modeling, assessment, and predictive capabilities needed to
13 document and predict climate changes and impacts, and to guide planning and
14 decision-making
- 15 • Develop standards, evaluation criteria and performance objectives to ensure that
16 the National Climate Service meets the evolving information needs of the public,
17 policy makers, and decision makers in the face of a changing climate

19 ***Recommendations for Establishing the National Climate Service***

20 In addition to building NOAA's capacities toward a National Climate Service, NOAA
21 will need to address several key challenges pertaining to the establishment of this
22 Service:

- 1 • Work towards establishing a shared understanding of the National Climate
2 Service and the national climate services partnership and their roles, both inside
3 and outside of NOAA
- 4 • Create a plan for the governance and organizational structure of the National
5 Climate Service
- 6 • Plan and invest in reducing the major science gaps that exist in the current
7 understanding of climate and its impacts
- 8 • Assess the needed resources that this Service would draw upon including
9 workforce, infrastructure, and funding
- 10 • Determine how the National Climate Service will utilize NOAA's existing
11 networks of environmental services

Closing

This strategic plan provides a framework for a National Climate Service that will lead a national climate services partnership. This plan outlines the vision, mission, goals, and capabilities, and provides recommendations for action items that will place NOAA in a position to create a National Climate Service and provide leadership in a national climate services partnership. The national climate services partnership will develop and deliver research, information, and services to enhance society's ability to understand, anticipate, mitigate, and adapt to climate variability and change.